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Further observations on Taxodium

ROLAND M. HARPER

Since the publication of my paper on *Taxodium distichum* and related species * I have spent three more seasons in the coastal plain of Georgia, where I have now had the southeastern representatives of this genus under observation every month in the year except December, and I am now able to present some additional notes on them.

One reviewer of that paper (who is among the foremost of American phytogeographers, but not a professed systematist) has expressed the opinion "that *Taxodium imbricarium* will prove to be merely an ecological variety" of *T. distichum.* If this is the case, then some hundreds if not thousands of long established and universally accepted species will have to be placed in the same category. But the fact that these two species remain perfectly distinct when cultivated in the same soil (as noted on the last page of my previous paper), not to mention the considerable difference in their geographical distribution, ought to dispose of the "ecological variety" question. From all the evidence at hand at the present writing the conclusion is irresistible that *T. imbricarium* is abundantly distinct. The only substantial argument which could be urged against the recognition of this species is the occurrence of trees intermediate (in some characters at least) between it and *T. distichum.* But these are outnumbered a hundred to one (in Georgia at least) by typical and unmistakable specimens of *T. imbricarium,* † and should not invalidate the species any more than the intermediate forms in countless other genera do.

My work will doubtless admit of some criticism from a geological standpoint, however. My attention has been called by a geologist friend to the fact that what has been passing under the name of the Lafayette formation in Georgia and some other states is probably divisible into two or three different horizons. One of these may be the Grand Gulf, which has recently been a subject of considerable controversy.* Until geologists have settled this point among themselves I can make no satisfactory corrections in this respect. However, when the whole truth is known these two species of *Taxodium* will surely be found to stand always in some such relation to the superficial formations as I have already indicated, whether my present identification of these formations is correct or not.

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* Bull. Torrey Club **29** : 383–399. June, 1902.

† I have records of three or four hundred stations in Georgia for *T. imbricarium*, at each of which there may be from ten to several thousand individuals; while the intermediate form I have seen only about twenty times, and never more than a hundred trees at a time.

It is absolutely certain though that *Taxodium distichum* grows directly on the underlying rocks of the coastal plain, as I had excellent opportunity to observe on the Flint River east of Americus in July, 1902, when the water was unusually low for that time of year (see *figure 1*). And similar conditions have doubtless existed for thousands of years, for according to Bibbins † fos-

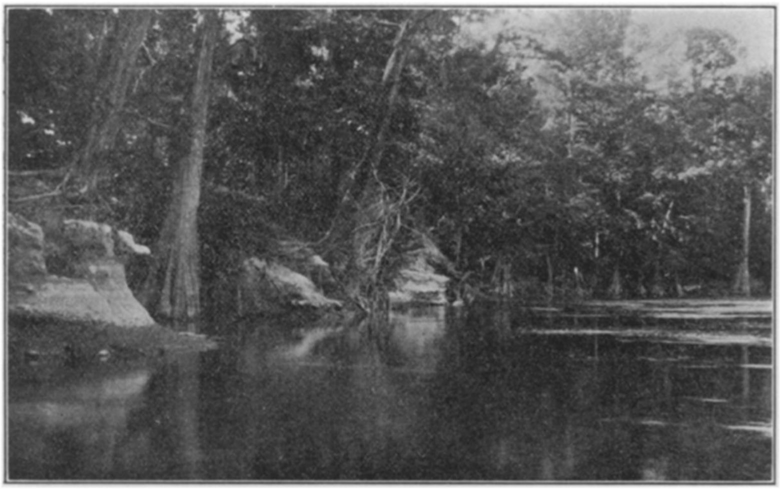

FIGURE 1. *Taxodium distichum* growing on Lower Oligocene rocks on right bank of Flint River, Sumter County. July 5, 1902.

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* For a discussion of the nomenclature, relationships and distribution of this formation the reader is referred to the following papers in Science (new series), all entitled "The Grand Gulf Formation": — Smith & Aldrich, **16**: 835–837. November 21, 1902; Dall, **16**: 946, 947. December 12, 1902; Smith & Aldrich, **18**: 20–26. July 3, 1903; Dall, **18**: 83–85. July 17, 1903; Hilgard, **18**: 180–182. August 7, 1903.—See also Dall, Trans. Wagner Free Inst. Sci. **3**: 1561–1564. 1903.

† Plant World **1**: 164–166. August, 1898.

sil cypress stumps have been found on the shores of Chesapeake Bay with their roots imbedded in Cretaceous strata. It was at first supposed that the stumps themselves were of Cretaceous age, but subsequent investigations by the same author and Dr. Hollick have shown that the trees grew in Pleistocene times, sending their roots down into the Cretaceous strata on which they stood, and the stumps have been preserved *in situ*.

The actual contact of *T. imbricarium* with the Lafayette formation (or what passes for it) has not yet been observed, and could hardly be without having special excavations made for the purpose, but I have often seen this formation exposed (particularly in railroad cuts) within a few yards of colonies of this tree.

The relations of the two species under consideration to the geological formations are well illustrated at Bull Head Bluff on the Satilla River in Camden County, Georgia, which I visited in August, 1902. The bluff is about eight feet high, and exhibits the following section, in descending order: Two feet of Columbia sand, five feet of reddish clay (Lafayette?), and about a foot of stiff bluish clay (doubtless Tertiary, but exact age unknown). Typical *Taxodium distichum* grows here along the water's edge, below the Lafayette, while a hundred yards or so away from the river equally typical *T. imbricarium* flourishes in moist pine-barrens.

Ecologists have had a good deal to say recently about drained and undrained swamps, and the remarkable differences in their flora. If they would examine the habitats of the two taxodiums they would find that *T. distichum* always grows in "drained" swamps, and *T. imbricarium* usually in ponds, which are of course "undrained." In the Southeastern States, as in other parts of the country, there are very few species common to both habitats. In their relation to limestone the taxodiums are equally distinct, *T. distichum* being essentially a limestone-loving species and *T. imbricarium* just the opposite. (The latter often, perhaps always, grows over limestone, but never in contact with it, some more recent formation always intervening.)

There are also some additional morphological characters which I overlooked before, by which the two species under consideration may be distinguished. In Washington in the spring of 1902 my attention was called by Dr. J. N. Rose to a difference in the bark of cultivated specimens, that of *T. imbricarium* (cultivated there under the name of *Glyptostrobus*) being considerably thicker and more coarsely ridged than that of *T. distichum.* On my return to the field I soon found that the same was a constant and well-defined character of the wild trees, and it has since been of considerable assistance to me in studying their distribution, particularly in the winter months when the leaves were fallen.

There is also a marked difference in the knees, those of *T. imbricarium* being short and rounded, often almost hemispherical, while those of *T. distichum* are usually slender and acute, sometimes reaching a height of six feet (in the Suwannee River in Clinch County, for instance). The latter species seems to produce knees much more abundantly, Elliott's opinion to the contrary notwithstanding. In both species the height of the knees and that of the enlarged base of the trunk usually indicates the maximum level of the water in which they grow,* with the exceptions that in deep ponds the knees of *T. imbricarium* are entirely submerged or perhaps wanting, and in many creek swamps those of *T. distichum* are very small and do not grow as high as the enlargement of the trunk. In May, 1904, I saw in the pine-barrens near Douglas, Georgia, in a place which had once been a small mill-pond, some saplings of *T. imbricarium* with trunks perceptibly enlarged up to about six feet from the ground, which was just the height of the dam. In cultivation, where they are never inundated, it has been my observation that each species produces a slight but characteristic enlargement of the trunk. (The specimens on the grounds of the Smithsonian Institution and Department of Agriculture in Washington are good examples.) This does not agree with the recently published observations of Dr. S. M. Coulter.† In wet pine-barrens, where there is likewise no inundation, the enlargement of the base of *T. imbricarium*, though insignificant compared with what it is in ponds, is always present (see *figure 4*). In any one stream or pond the enlarged bases are all the same height, regardless of the size of the tree.

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* This was noted in the case of *T. distichum* by Dickeson and Brown in a paper on the cypress timber of Mississippi and Louisiana, in 1848 (Am. Jour. Sci. II. 5: 15–22).

† Rep. Mo. Bot. Gard. 15: 59. *pl. 15–18.* 1904.

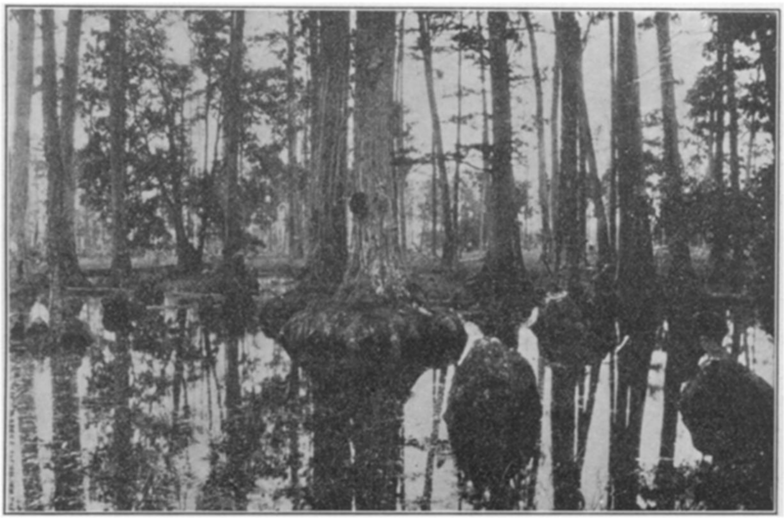

FIGURE 2. *Taxodium imbricarium* in a shallow pine-barren pond in Coffee County. July 24, 1902. Note the rounded knees and the very abrupt enlargement of the trunks. The water-level in this pond probably does not vary more than a foot or two.

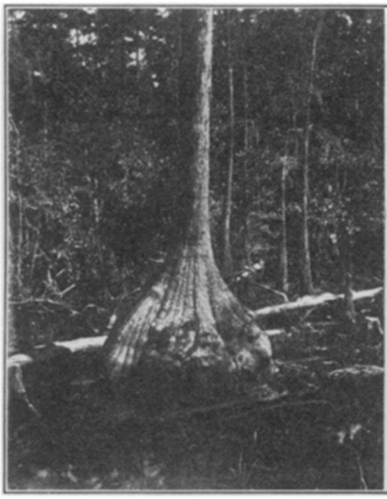

FIGURE 3. *Taxodium imbricarium* in Twenty Mile Creek, Coffee County. Sept. 24, 1900. Note the greatly enlarged base of the trunk and its broad rounded ridges.

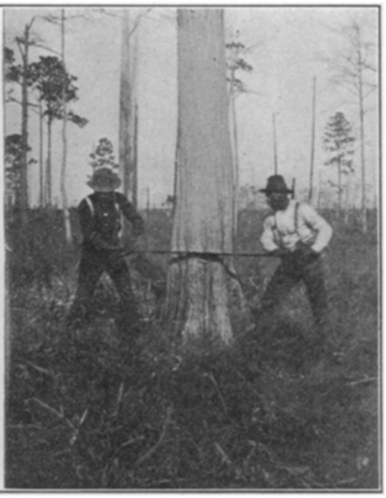

FIGURE 4. *Taxodium imbricarium* in wet pine-barrens near Douglas, Coffee County. Base of trunk not conspicuously enlarged. Several specimens of *Pinus Elliottii* in background. Feb. 3, 1904.

An examination last winter of some specimens of *T. imbricarium* which had been felled, showed the structure of the base of the trunk in cross-section. The broad longitudinal ridges of wood become pressed against each other as they grow, closing the sinuses between them (as shown in the accompanying diagrams), while in *T. distichum* the sinuses are open and rounded and the ridges rather sharp. Ericaceous shrubs (such as *Pieris nitida* and *Leucothoe racemosa*), growing close to the base of such a tree, often have their stems caught in the embrace of the swelling ridges and then appear as if growing out of the *Taxodium* above the ground. The climbing habit of *Pieris phillyreaefolia* * may have originated in some such way. In both species the base seems to be always hollow in old specimens, and knees often grow inside it.

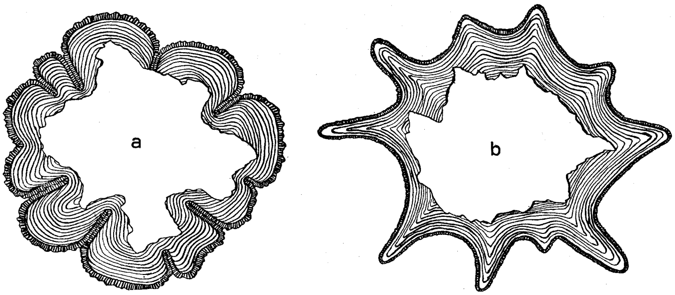

FIGURE 5. Ideal cross-sections of hollow enlarged base of trunk of *Taxodium imbricarium* (*a*) and *T. distichum* (*b*). (The annual rings in reality would be ten to fifty times as numerous as they are shown here.)

Another distinction (though rather a subtle one) between these two species is that in *T. distichum* the trunk is straight but not always erect, while in *T. imbricarium* it is erect but not always straight.

The following additional notes on the distribution of the two southeastern species may be of interest.

TAXODIUM DISTICHUM

In Georgia the inland limit of this species reaches the fall-line at the eastern border of the state, but diverges widely from it westward, following approximately the outcrop of the Eocene formations. On the Savannah River it ascends just to Augusta; on the Ogeechee and its tributaries it terminates somewhere between Louisville in Jefferson County and the Augusta Southern R. R. in Glascock; on the Oconee it is common in Laurens and Montgomery Counties, but terminates at or near the Central R. R. bridge in Washington and Wilkinson; on the Ocmulgee it ascends to Twiggs and Houston Counties; on the Flint to Macon County (I am told), but not quite to the twin cities of Oglethorpe and Montezuma; and on the Chattahoochee I have seen it only in Early County near Saffold, though it grows in low grounds near the river at Columbia, Alabama, several miles farther up. On the smaller rivers which rise below the fall line (and are therefore not muddy), it ascends the Satilla to Bull Head Bluff or beyond, the St. Mary's nearly to its head at the southeastern corner of Okefinokee Swamp, the Withlacoochee to Lowndes County, and the Ochlocknee to Moultrie. (It is mostly in some of these smaller rivers, such as the Canoochee, Ohoopee, Satilla, Suwannee, Allapaha and Withlacoochee, that the puzzling intermediate forms occur.) Near the coast, in the counties of Glynn and Camden in Georgia and Nassau in Florida, this species occurs away from the rivers in numerous extensive swamps, the character of whose flora points strongly to the absence of the Lafayette formation.

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* See Torreya 3 : 21, 22. February, 1903.

Its most frequent associates in Georgia are *Hicoria aquatica*, *Planera aquatica*, and *Nyssa aquatica* (*N. uniflora*).

Dr. R. Ellsworth Call[*] has published some interesting notes on the occurrence of *Taxodium distichum* in eastern Arkansas, in which he says among other things: "From the top of Crowley's Ridge, looking either to the east or the west, at those points which command the valleys of the St. Francis and the Cache, the cypress areas can be readily made out by the observer. The tops of the giant trees tower far above the heads of the intervening forests and give one the location of the swamps for hundreds of square miles."

Some outlying stations for this species in the Edwards Plateau of Texas (which includes Kerrville, mentioned in my previous paper) have been described by Hill and Vaughan,[†] who say in part: "The occurrence of the cypress is a peculiar anomaly. This tree, which ordinarily grows only in the swamps and bayous of the low subcoastal regions, attains an enormous size at the edge of the deeper holes near the heads of permanent water of the Pedernales . . . and other streams. These localities are at altitudes from 1,000 to 1,750 feet above the sea, hundreds of miles west of the great cypress swamps of the eastern tier of Texan counties, with which they have no possible continuity." (See also Bray, U. S. Dept. Agric., Bureau of Forestry Bull. 47: 53; 49: 16. 1904.)

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[*] Rep. Geol. Surv. Ark. 1889^2: 198–200. 1891.

[†] Ann. Rep. U. S. Geol. Surv. 18^2: 210, 211. 1898.

TAXODIUM IMBRICARIUM

This species is very abundant in the coastal plain of Georgia, where I have seen it in every county in which Oligocene or later rocks occur, *i. e.*, from the inland edge of the pine-barrens to Florida and the coast. On the way to Georgia in 1903 I saw it in Moore County, N. C., near the fall-line,* and in Hampton County, S. C. It is common in Nassau and Baker Counties in Florida, but no data are yet available as to its southern limit in that state.

Outside of the pine-barrens in Georgia there are several outlying stations for it, where it grows in shallow ponds. These have been noted as follows: In Richmond County between Adam and Adventure, in Jefferson near Wadley, in Washington near Sandersville, in Taylor near Reynolds, and in Terrell between Bronwood and Dawson. All these localities, according to the best information at present obtainable, seem to be underlaid by rocks of the Claibornian division of the Eocene. The Taylor County station is of interest as being the farthest inland, and most remote from the pine-barrens. At this point the *Taxodium* is in imminent danger of extinction, most of the trees having been already cut and used up (it being apparently the only cypress pond known in the vicinity), and few if any young trees were seen. The principal vegetation of this pond is *Liquidambar*, with a few *Crataegus aestivalis* bushes.

Toward the coast *Taxodium imbricarium* extends nearly to Brunswick, within two or three miles of salt water and not over ten miles from the open ocean. There its habitat and associates are much the same as they are fifty or a hundred miles inland.

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* See Torreya 3: 123. August, 1903.

This turns out to be the predominating tree in Okefinokee Swamp, as already announced,* where it grows in all the sphagnous bogs, with *Pinus Elliottii*, ferns, *Dulichium*, *Eriophorum virginicum*, aroids, orchids, *Drosera*, *Sarracenia*, *Ilex*, ericaceous shrubs, etc., just as several other conifers do in the cedar-swamps and peat-bogs of the North. It is said to attain enormous dimensions there, but I did not penetrate far enough into the heavily timbered portions of the swamp to verify this. Elsewhere in Georgia it is nearly always associated with *Pinus Elliottii*, and commonly with *Pinus serotina*, *Dichromena latifolia*, *Ilex myrtifolia*, *Magnolia glauca*, *Hypericum fasciculatum*, *Nyssa biflora*, *Oxypolis filiformis* and *Pinckneya pubens*.

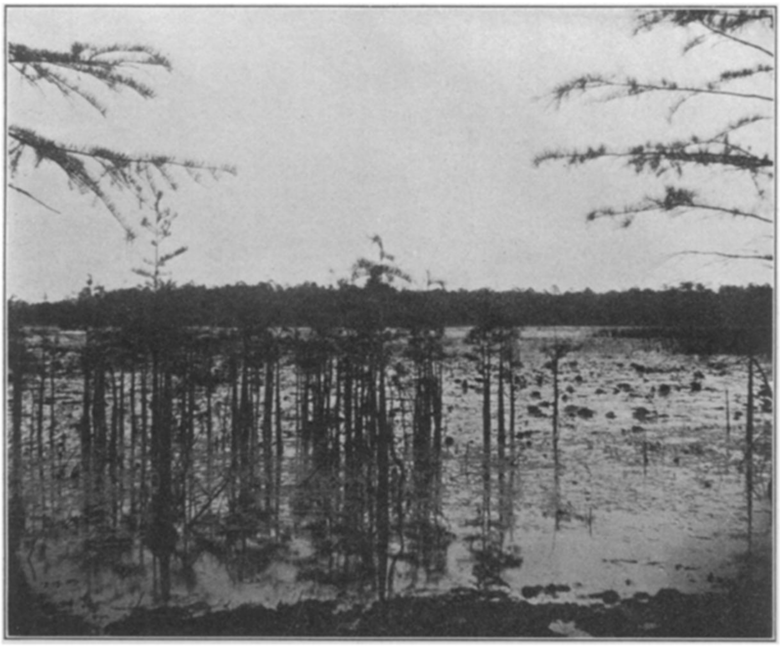

FIGURE 6. View of Cane Water Pond, Decatur County, showing a group of saplings of *Taxodium imbricarium* in center, and branches of two older trees at the sides. Aug. 6, 1903. Note the gradually tapering trunks of the saplings (doubtless due to great variations in water-level), and the erect leaf-bearing branchlets on all the trees.

The natives in Georgia do not seem usually to make any dis-

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* See Torreya 2: 157. Oct. 1902; and Science II. 17: 508. 27 March, 1903.

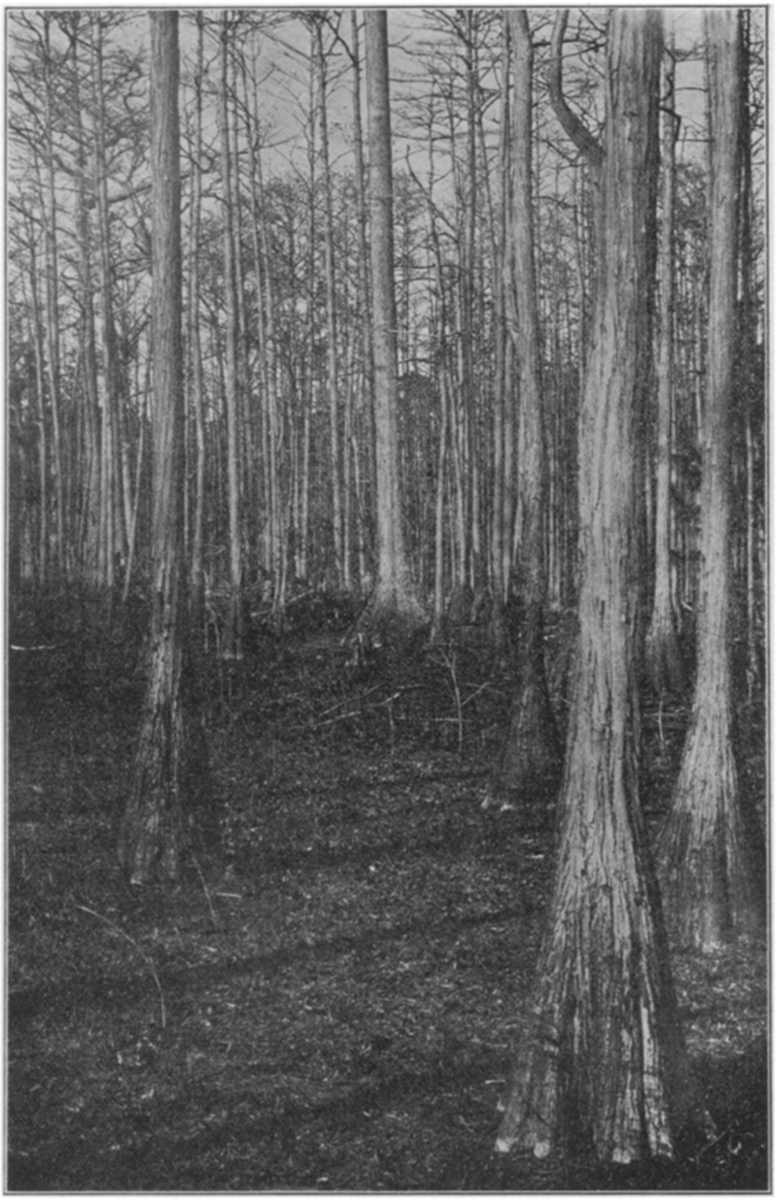

FIGURE 7. Nearly pure association of *Taxodium imbricarium* in a shallow pond (dry at the time the photograph was taken) about three miles east of Valdosta, Lowndes County. Feb. 13, 1904. Note the rather coarsely ridged bark, the erect trunks, and their enlarged bases all of the same height. One or two saplings of *Pinus Elliottii* are visible.

tinction between the two species of cypress. Lumbermen recognize several varieties, such as white, black and red cypress, based on the appearance of the wood, but as they do not correlate these with any leaf or bark characters, I cannot see but what all these names apply to *T. distichum*, which furnishes practically all the cypress lumber on the market. *T. imbricarium* is used to some extent for posts, telegraph poles, and crossties, but just why it is not used for lumber I have not satisfactorily ascertained. Elaborate preparations were made several years ago for getting this species out of Okefinokee Swamp and sawing it up, but for various reasons this enterprise was abandoned after it had been in operation a short time. The danger which thus threatened what is probably the finest body of *Taxodium imbricarium* in existence, which it has taken Nature thousands of years to accumulate, is not altogether past, but may be revived at any time. It is to be hoped that rational methods of lumbering will be universally adopted before the devastation of Okefinokee Swamp is again undertaken.

The illustrations selected to accompany this paper are mostly of *T. imbricarium*, as botanists will be more familiar with the other species, which has often been described and figured. The most conservative should now admit that for phytogeographical purposes at least it is much more desirable to regard the two species here discussed as distinct.

COLLEGE POINT, NEW YORK.